02/2000 PASTING GHS32 PLOTS INTO YOUR OWN DOCUMENTS
12/1999 GHS CONFIGURATION DIRECTORY ~CSI_SYS.CFG
03/1999 Applying CFR 171.055 for Sailing Vessels
07/1998 User Variables and Variable Arithmetic
06/1998 Evaluating Vessels for Weather Criterion
05/1998 HOW TO PRINT TO A NETWORK PRINTER
12/1997 Getting your Printer to work with GHS
11/1997 Misleading, Bewildering and Unreliable Stability Criteria
11/1996 Water on Deck
08/1996 GHS LIMIT commands based on Navy stability criteria
06/1997 Directory Management in GHS, BHS and BHS/Yacht
06/1997 The PROJECT Command
04/1997 The Q-Menu System for GHS, BHS and BHS/Yacht
04/1996 The MAXVCG Process
04/1996 GM in GHS
03/1996 Accuracy considerations in selecting station spacing
11/1995 Evaluating Vessels for Weather Criterion (46 CFR 170.170)
06/1995 Wind and Rolling Calculations
06/1995 GHS/BHS Demonstration Run File for End Launching
05/1995 Wind Heeling Moment Calculations
04/1995 Downflooding Points
04/1995 Using Free Surface Moments in Stability Calculations
04/1995 Introduction to Macros
04/1995 Building a Swath
04/1995 Tank Modes and Types
04/1995 USCG Severe Wind and Rolling Criterion for Fishing Vessels
03/1995 Interfacing a Digitizer with Section Editor
01/1995 Probabilistic Damage:The IMO Subdivision Index for Cargo Ships

GHS CONFIGURATION DIRECTORY ~CSI_SYS.CFG

12/99

GHS, SE, and related programs store hardware configuration information in a hidden directory named "~CSI_SYS.CFG". This directory is located either on the same drive as specified in the TEMP or TMP environment variable (if it exists), or else the first available drive letter (starting with "C:"). As such, the GHS configuration directory is normally C:\~CSI_SYS.CFG.

A problem can arise in network installations where access to the root of local hard drives is restricted. In such cases, the GHS configuration directory may not be created, causing problems such as failure in

the GHS "ENTER SE" command. The solution is for network administrators to create a C:\~CSI_SYS.CFG directory with read/write access on every restricted- access computer that uses GHS.

----------o----------

PASTING GHS32 PLOTS INTO YOUR OWN DOCUMENTS

2/2000

With GHS32's Windows-based printing, you can now save plots to files in Encapsulated PostScript (EPS) format, manipulate them using an image-editing program, and then insert them into a word-processing document. Here's how:

1. Click Start, Settings, and Printers to open the Printers window.
2. In Windows 95/98, double-click Add Printer in the Printers window. Click Next, choose Local printer, then click Next again. Choose a PostScript printer in the list (use "HP LaserJet 4P/4MP PostScript" under manufacturer "HP" if available), and click Next. Choose the port FILE: and click Next. Call the new printer "EPS File", make sure it is not your default printer, and click Next. Choose "No" when asked whether you want a test page, then click Finish. If your Windows installation files are not present on your hard drive, you will now be asked to insert your Windows installation CD or a floppy disk. Wait until the printer EPS File appears in your Printers window.
3. Right-click on EPS File and choose Properties. Select the PostScript tab and click the triangle next to PostScript output format, then choose "Encapsulated PostScript (EPS)". Click OK to close. Your system is now configured to produce EPS file versions of GHS32 printouts.
4. In GHS32, enter PRINT CONFIGURE to get a pop-up window, click the triangle next to the Name field, choose "EPS File", and click OK to close. This print method will be used by GHS32 until it exits, but when GHS32 is restarted, the Windows default printer will be restored for GHS printing.
5. Be aware that each EPS file corresponds to a single page of printed output, so if your report is more than one page long, an error message will be displayed and only the first page will be saved in the EPS file. To get an EPS image of a particular plot within a multi-page report, make a backup copy of the .PF file, edit it with a word processor, delete everything before the ".PLOT PAGE" line for the page you want to save, delete everything after the next ".END PAGE" line, and save as a text file.
6. In GHS32, enter PRINT followed by the name of the .PF file to print. When a window pops up to ask for the location of the "Print To File", choose any file name and folder you want, but make sure it ends with the .EPS file extension (e.g. PP.EPS).
7. Once the EPS file has been created, you can open it in an image-editing program (such as Adobe PhotoShop or ImageReady), modify it (such as by adding additional labels or cropping off unneded portions), and save it in the desired image format (such as EPS, BMP, JPEG, GIF, TIFF, etc.).
8. Depending upon your image format and word-processing software, you should now be able to insert the modified image into your word-processing document. For example, in Microsoft Word, you would click the Insert menu then choose Picture From File and select your file (which could be in EPS, BMP, JPEG, GIF, TIFF, or other image formats). In Microsoft WordPad, you would click the Insert menu, choose Object, click Create from File, and select your file (which would need to be in BMP format to work).

----------o----------

GM in GHS

4/96

GM, the distance from the center of gravity to the metacenter, is calculated in two different ways: 1) from the waterplane (BM - BG); and 2) from the slope of the righting-arm curve.
Note that the definition of GM implies a certain equilibrium; i.e., that the center of gravity and center of buoyancy lie on a line which is perpendicular to the waterplane. (By definition, the center of buoyancy and metacenter always lie on such a line.) If GM is considered to apply in a non-equilibrium condition, it is only by hypothetically moving the CG to a position in line with the CB.

GM from the GHS Command

The GHS command, when issued without a draft parameter, computes and displays GM at the present waterplane. It uses the waterplane method. If free surface is present, it is taken into consideration when calculating BM, not BG. If there is a formal FSM which differs from the true FSM, the formal

FSM is used unless a /TRUEFSM parameter is present.

The GHS command does not produce or require equilibrium. If the present waterplane is not one of equilibrium, hypothetical TCG and LCG coordinates are assumed which put the CG in line with the CB. The VCG is not changed. Heel axis rotation is ignored: GMT is always in the ship's transverse direction and GML is always in its longitudinal direction.
The GHS command does not involve the magnitude of the ship's weight: only the vertical position of its CG. Therefore, the present waterplane need not have a realistic relationship with the weight or center of gravity in order to show GM.
In the presence of a heeling moment, equilibrium can exist in the sense that the heeling moment equals the righting moment. In order for there to be a righting moment, CG and CB must not be in line. Therefore, the sort of equilibrium demanded by GM does not exist. The GHS command ignores heeling moment. It creates its hypothetical equilibrium as described above regardless of whether equilibrium with the heeling moment exists.
At any given inclination, an equivalent of the heeling moment can be produced by moving the CG in a direction parallel to the waterplane until it comes into line with the CB. This usually involves shifting the VCG. Therefore, if the correct GM is to be obtained from the GHS command with respect to a heeling moment, the VCG must first be adjusted.

The GMTMMT Command

The GMTMMT command takes a GMT moment as its parameter. Holding the waterplane constant, it modifies the light ship weight and CG such that the given moment divided by the weight equals the GMT from the waterplane. The true free surface is always used.

GM from the STATUS Command

The STATUS WPL command also will compute and display GM using the same method as the GHS command, except that it does not show GM at all if equilibrium, in the strict sense of the righting arm being zero, is not present.

GM from the RA Command

The RA command computes and displays GM (in the transverse, or direction of heeling) when one of the GM LIMIT commands is in effect. It will also compute and display GM on the plot in some cases even when no GM LIMIT is in effect.

Two cases of GM are recognized by the RA command: GM at equilibrium and GM upright (zero heel). Whether the RA command is to deal with one or both of these GM cases is predetermined by LIMIT commands.

The RA process can compute GM from the waterplane or from the slope of the righting-arm curve. In some cases it blends a combination of both. Normally, it uses the waterplane only, unless the heel axis has been rotated.

When the RA process derives GM from the waterplane, it automatically projects the CG into line with the CB in a direction parallel to the waterplane. Therefore, it produces the correct GM when a heeling moment is involved insofar as the waterplane is concerned.

When the RA process derives GM from the righting arm curve, it samples small angles of heel on either side of the relevant angle in order to determine the slope of the curve.

The RA command will tend to use the righting-arm slope method if the parameter /GMRA is included. However, it will also look at the GM from the waterplane and use a blend of the two unless there is a large difference, in which case it uses the slope of the righting arm curve. This gives a smoother response in the presence of waterplane discontinuities while keeping as much agreement with the waterplane method as possible.

Waterplane discontinuities cause knuckles in the righting-arm curve at which its slope and the GM are discontinuous. By using the sampling method to determine the slope of the righting-arm curve, the GM discontinuity is smoothed, which helps when optimizing for a particular GM value (which may not in fact exist). Therefore, the /GMRA parameter can be used with the MAXVCG, SOLVE VCG and SOLVE WEIGHT commands to improve their performance when GM limits are in a controlling position.

When the heel axis has been rotated, the righting-arm slope is always used and the GM is actually in the direction of heel, not the transverse direction.

In the presence of a heeling moment, the GM which the RA process derives is always with respect to the absolute righting arm curve. Therefore, unless the heeling moment is constant at the angle at which GM is being considered, the residual righting arm curve will have a slope which differs from the reported GM.

While the RA process can involve two cases of GM, the RA plot can only show one GM line. If both cases are present, it shows GM upright. In the absense of GM limits, the RA plot shows GM only if the range of heel angles includes equilibrium.

----------o----------

The MAXVCG Process

4/96

The purpose of the MAXVCG command is to produce curves of maximum VCG vs. displacement based on a given stability criterion. The assumption behind this is that all loadings which produce a given displacement and LCG have the same maximum VCG as well as having zero TCG. Therefore, when free surface is involved in a particular load, the VCG must be adjusted for the free surface effect before comparing it with the maximum VCG. The use of maximum VCG data should be restricted to loads where the TCG is zero.

The MAXVCG command takes a series of weights and LCGs as inputs and finds the corresponding maximum VCG for each combination of weight and LCG, assuming that the TCG is zero. Alternatively it accepts drafts and trims as inputs which it converts to weights and LCGs using the intact waterplane at zero heel.

When trim, rather than LCG, is an input, the program must adjust the LCG in concert with the VCG in order to maintain the given initial trim. This requires additional steps and takes additional time.

Since the details of any particular loading are irrelevant during the generation of maximum VCG curves, the present weight and tank load settings are ignored during the process. The present fixed-weight VCG, however, is taken as the "floor" value. If the MAXVCG process finds that a maximum VCG is below the floor, it does not attempt to find its value but merely reports that it is less than the floor value.

In addition to displaying a table and graph of the maximum VCG curves, the MAXVCG command causes a "data base" of the maximum VCG information is retained in memory. This data base is also saved on a disk file by means of the SAVE command. Although the data held in memory is lost when the GHS session ends, it may be restored by RUNning the file which was written by the SAVE command.

This data base of maximum VCG data is accessible through two commands:

1) a special short form of the MAXVCG command; and

2) the LOAD EDIT command, which is available only when the Load Editor module is included in the GHS installation. When a particular condition has been defined (weights and tank loads) and equilibrium has been found nd the displacement, LCG and TCG are within the limits required by the maxvcg data base, then the command MAXVCG (without parameters) will access the data base and report the maximum VCG

which corresponds to the present condition.

The maximum VCG curves and the data base which result from a MAXVCG command are based on certain factors which must be identically present whenever the curves are applied. These factors include the stability criterion, the heeling moment and the configuration of damage. When any of these factors are changed, the data base becomes invalid and can no longer be accessed.

It is possible to produce a composite data base consisting of the lowest maximum VCG values from more than one execution of the MAXVCG command. Details can be found in the MAXVCG command section of the Command Dictionary or by typing HELP MAXVCG at the GHS prompt.

When damage is present (tanks with type = FLOODED) the MAXVCG command keeps the tanks in the flooded state but it still assumes that the TCG is zero. This means that the resulting maximum VCG data does not apply to load conditions where the flooded tanks carry any load before damage, since the loss of the load would change the condition.

When the assumptions inherent in the maximum VCG curves cannot be satisfied, it is necessary to analyze each case of loading separately. This can be done by beans of the SOLVE MAXVCG command. After setting a load condition (weights and tank loads) the SOLVE MAXVCG command will find the maximum value of the lightship VCG (or the VCG of a particular added weight) which satisfies the present stability criterion. There are no restrictions on the TCG or the tank loading prior to damage.

----------o----------

The Q-Menu System for GHS, BHS and BHS/Yacht

4/97

The Q-Menu system can be used as an alternative to commands. It enables you to perform many of the Main Program functions by making selections from menus rather than typing commands. It does not apply to model building, but only to the analysis phase. With the menus you can select and read a Geometry File, set light ship weight, add other weights, load tanks (if applicable), etc. Then you can create a report showing the hydrostatic properties and stability information for the vessel in that condition.
The entire menu system itself consists of Main Program commands and text files. That is, the menus and the actions which they perform are all done with commands. In fact, the Q-Menu files are nothing more than Run Files and text files containing documentation. Therefore, a user who is thoroughly familiar with the commands can modify and extend the menu system.
The menu system as distributed does not provide access to all of the features available through the commands. If it did so, it would certainly be unduly complex. However, as noted above, it is possible to extend it and thereby to include almost any feature which you might want.
It is also quite easy to switch back and forth between the menu and direct commands.
Installation

These simple steps will install the Q-Menu system:
1) Copy all files in the Q-MENU distribution to the directory which contains your GHS.KEY file. This is normally your GHS or BHS program directory. The Q-MENU files are normally distributed on one of the GHS or BHS distribution diskettes, in which case they will be copied to the GHS or BHS directory along with the other during installation.
2) Rename the file QMENU.LIB to MENU.LIB.
3) If there is a file with the extension ".LIB" and the name of the main program; e.g. GHS.LIB, either delete it or make sure that it does not redefine the F function key. If such a file is present in the program directory it will be run when the main program starts.

Starting up the Menu System
1) Make the directory (folder) which contains the Geometry File you wish to use the current directory. This can be done before running the main program by opening that directory. Or it can wait until after you have started the main program (see step 3).
2) Run your main program (GHS, BHS or BHSY).
3) If you have not already done so in step 1, change to the directory which contains your Geometry File using the CHDIR command. You can find out the name of the current directory by using the PROJECT * command. This sets the project name to the name of the current directory.
4) Unless it has been changed through the action of an initialization Run File such as GHS.LIB, the F9 key will start up the menu system.

Using the Salvage Extensions
With GHS, the Q-Menu system has a variation which is more useful for salvage work. To enable the salvage menu:
1) Edit the file QVERSION.LIB. Place a comment mark (`) before the line which runs QMAIN-G and remove the comment mark before the line which runs QMAIN-S.LIB.

Modifications
Modifications and extensions can be made to the Q-Menu system without changing the files as distributed. This ensures that future updates from the vendor will not overwrite the files you have changed. You can put your extensions and modifications in new files and attach them by adding lines to the QVERSION.LIB file similar to the one which calls QUSER.LIB.
See QUSER.LIB for examples of how to add stability criteria and extend the menu system.

----------o----------

GHS LIMIT commands based on Navy stability criteria

8/97

Intact severe wind and wave:

HMMT WIND /C2
ROLL = 25
LIM RISE > 0.667
LIM RESIDUAL RATIO FROM ROLL TO RA0 > 1.4

Lifting, Crowding & Turning:

HMMT = x /CS
LIM RISE > 0.667
LIM ABS ANGLE AT EQU < 15
LIM ABS RATIO FROM EQU TO RA0 > 1.667

Towline adds to Lifting:

LIM ANGLE FROM MAX TO ABS 40 OR FLD > 0
LIM ABS RATIO FROM EQU TO ABS 40 OR FLD > 1.667

Damage:

LIM ABS ANGLE AT EQU < 15
LIM RESIDUAL RATIO FROM ROLL TO ABS 45 OR RA0 > 1.4
LIM RESIDUAL RATIO FROM ROLL TO FLD OR RA0 > 1.4
`roll angle depends on displacement

These interpretations of the Navy criteria are not necessarily appropriate for every type of vessel inevery loading condition and in all types of service. Additional limit commands and/or changes to the parameters as shown above may be needed in order to guarantee adequate stability.
A value attained for the RISE limit (A) can be converted to the value of the ratio of righting arm at equilibrium to righting arm at max (B) as follows:

B = 1 / (1 + A)

For example, A = 0.667 yields B = 0.6.

A value attained for the ABS RATIO limit (A) can be converted to the value of the ratio of residual area to total area (B) as follows:

B = 1 - 1/A

For example, A = 1.667 yields B = 0.4.

To allow for off-center weights, the transverse center of gravity can be set to an appropriate value. If
it is desired that the transverse center of gravity of the total weight (including tanks) be 0.05, the following command can be used:

WEIGHT (TOTAL) *, *, 0.05, *

This will set the transverse componenet of the light ship CG such that the overall TCG comes out to be 0.05. Since the MAXVCG command ignores the TCG (as well as tank loads), this will not affect MAXVCG curves.

HOW TO PRINT TO A NETWORK PRINTER FROM MS-DOS-BASED PROGRAMS UNDER WINDOWS NT (adapted from Microsoft Support Article Q154498 dated October 20, 1997).

5/98

By default, most MS-DOS-based programs print directly to either LPT1 or LPT2. However, under Windows NT, the output is not automatically routed across a redirector to a shared network printer unless you establish a persistent connection using NET.EXE.
To do so, use the following syntax at a command prompt:
NET USE LPTn: \\server\printer /PERSISTENT:YES
When printing to a Novell Netware 3.12 queue, Microsoft suggests using the following syntax instead:
NET USE LPTn: \\server\queue
If the port is redirected successfully, the following message should appear:
The command completed successfully
To disconnect persistent LPTn: connections, use the following syntax:
NET USE LPTn: /DELETE

ALTERNATE PROCEDURE FOR NOVELL NETWARE
Some Novell Netware users report that the above Microsoft commands do not work for them, and suggest replacing them with the following Netware commands:
To connect a networkprinter to LPTn, use the following syntax::
CAPTURE L=n Q=networkprinter NB NFF NT TI=30
To disconnect, type:
ENDCAP

----------o----------

Misleading, Bewildering and Unreliable Stability Criteria

11/97

Difficulties with Equilibrium Angle as a Measure of Stability

The ability to resist a heeling moment resulting from wind, passenger crowding, etc. is often measured by the heel angle which is induced by the heeling moment. However, requiring that this angle of equilibrium be less than some given angle such as 14 degrees or some characteristic angle such as margin line immersion, downflooding point immersion or half freeboard does not in itself guarantee finite stability with the heeling moment. It says nothing about what happens if the heel is increased a bit farther.

With some vessels in certain conditions it is possible to meet such a criterion and yet have virtually no stability beyond the angle of equilibrium. Therefore, if the criterion envisions an actual or possible operating condition, it must be augmented by some measure of stability with the heeling moment in effect. Possible augmenting provisions would be a minimum range of stability, a minimum area, or a mimumum residual righting arm.

Difficulties with Angle of Maximum Righting Arm

The angle at which a righting arm curve reaches its maximum value can never be known precisely. The reason for this is that it is a property of the derivative of the righting arm curve, not of the curve itself. A property such as the angle of equilibrium is an angle at which the righting arm curve is zero. The angle at maximum is the angle at which the derivative of the curve is zero.

While a mathematical curve may have a precise derivative, a curve representing data obtained by experiment always contains some degree of uncertainty. Differentiation always exaggerates the uncertainty just as integration diminishes the uncertainty.

Whether measured by inclining a physical ship or inclining a computerized model of the ship, the righting arm curve contains experimental errors which are exaggerated by differentiation. Therefore the angle of maximum righting arm cannot be known with a precision comparable to the precision of the angle of equilibrium.

The differentiated curve (which plots the slope of the original curve) is typically more "bumpy" than the original; and it may go through many more slope reversals than the original. The closer you look; i.e. the more samples or angles you take, the bumpier it gets. This is because for closely-spaced samples the predominant difference is the experimental error: an attempt to examine the "fine structure" of the curve finds only the "noise" of the experimental error. Indeed, if no distinction is made between the property being measured and the noise, the results will be unrepeatable and bewildering.

Take, for example, a righting arm curve which actually has a "ledge"; i.e. for some range of angles the arm stays constant. Adding to this the experimental error, you find that it is not quite constant; in practice there will most likely be an angle of maximum perceived value within that range. While it may be insignificant that this so-called angle of maximum is not quite true (in fact there is no angle of maximum in the range) it may be significant that a later attempt to find a maximum in the same range comes up with a different angle due to a different stream of experimental errors.

This fact causes difficulty when the angle of the maximum becomes the controlling limit when attempting to find a maximum VCG which just satisfies the limit. Each time a slightly different VCG is introduced, a different stream of experimental errors, exaggerated by the differentiation, influence the angle of the maximum. For some range of VCG variations, the experimental errors (which are not proportional to the change of VCG) will be more significant than the actual change in the curve do to the change of VCG. This tends to bewilder the process of solving for the maximum VCG since the

relationship between the VCG and the limit margin has become "noisy" and when taken at fine enough intervals is essentially random.

It is unfortunate that the angle of maximum righting arm has been included in some stability criteria. While the computational difficulties are not unsurmountable, the results often bear the

effects of the experimental error. This must be understood by those dealing with the results and appropriate allowances made.

GM at Equilibrium

When the equilibrium angle is not upright, increasing the VCG tends to increase the equilibrium angle. If it so happens that this new heel angle encounters new buoyancy of sufficient magnitude to greatly boost the transverse moment of waterplane inertia, the new GM may actually be higher than the original. Therefore, it is possible that the relationship between GM and VCG at equilibrium is the reverse of what would normally be expected.

Jumps in the Area to RA0

If you have a double-humped righting arm curve, and your area or area ratio limit puts the valley between the humps right at the axis (or just touching the heeling arm curve), there will be a discontinuity in the area and probably in the area ratio as the VCG is varied slightly. If the value called for in hte limit is in the discontinuity there will be no solution. The VCG which puts the valley just slightly positive may be considered acceptable; however, with a slightly higher VCG (or stronger wind) the vessel would hover at the angle of the valley -- not capsizing further but not returning to the initial equilibrium either.

----------o----------

Getting your Printer to work with GHS

12/97

If you are having trouble printing from GHS, here are some things you can try.
First, make sure you can print a simple text file, using the printer port you have specified through the GHS command PRINTER CONFIGURE. To verify this, use the COPY command from the DOS prompt. For example, if the printer is on LPT1,

COPY C:\AUTOEXEC.BAT LPT1
You may have to do a manual page eject to get the page to finish printing.
This should work equally well for any printer, regardless of what type it is.
If this does not work and you are running in windows, try it from DOS mode. If it still does not work, the problem must be:
1) The printer is not properly connected to the port you specified.
2) The printer does not have a text mode.
If it works from DOS mode but not from a DOS window, Windows probably does not have the port mapped to the printer. Check your Network printer settings. In Windows 95 and NT 4.0 go into Network Neighborhood and check the printer mapping. First find your printer, then look at the File menu and select "Capture Printer Port" which allows you to assign LPT1, etc. to the printer. GHS cannot handle a port beyond LPT3 (it only can access LPT1, LPT2 or LPT3).
If your printer does not have a text mode, you will have to print your GHS output files through a Windows program such as WordPad or WMGHS (Windows Manager for GHS).
If the COPY test does work, try the following (assuming LPT1 and HPLASER for your printer type --substitute your actual printer type for the HPLASER keyword):

PP C:\AUTOEXEC.BAT LPT1 HPLASER

If you are not sure of the available printer type keywords, you can get a list on the screen by typing PP alone without any parameters. If this works, you can certainly print text from GHS.
To test the graphics printing, try the PPTEST.BAT which came with GHS. For example,
1) Go to the DOS prompt and change to the GHS directory (e.g. CD \GHS), then enter,
PPTEST HPLASER LPT1
Note that the order of the parameters is reversed from the order required by PP.
This should print a page which is a combination of text and graphics. There should be a rectangle near the middle of the page which measures 2" x 2".
If this works, you can certainly print text and graphics from GHS. Make sure that you give the same printer type keyword and port in response to the PRINTER CONFIGURE command. You only have to do this once (unless you change printers or ports) since GHS records the printer type and port in its configuration file (GHS.CFG).

----------o----------

Directory Management in GHS, BHS and BHS/Yacht

6/97

Note: Most of these features are available only in versions 6.52C and later.

DIR .HERE
Displays the current directory path on the screen.

CHDIR .START
Changes to the directory from which the program was originally started. Note: The program now returns to the Start directory after QUIT.

CHDIR .PROGRAM
Changes to the directory in which the program is found.

CHDIR d:\
Changes to the indicated drive.

MESSAGE PATH
Displays the paths to the following directories:

Start: Where the program was started.
Temp: Where temporary files are stored.
Key: Where the GHS.KEY file was found.
Program: Where the program files were found.

PROJECT path
Switches to the directory indicated by the given path. If the directory does not exist, it is created. It also records path for future reference.

Note: path must contain at least one back slash (\).

Example:
PROJ C:\PROJECTS\9705

This changes to the subdirectory 9705 within the master directory PROJECTS on drive C. It also records these directory paths in a special file (GHS.PRJ) so that the full path to the project directory need not be given in the future.
Special cases:

1) If path ends with a back slash, it is taken to be the path to the master directory only.
Example:
PROJ C:\PROJECTS\
This changes to the given master directory and lists the existing project subdirectories to choose from.

2) If path begins with the only back slash, it is taken to be the project sub directory name only. The path to the master directory will be the same one established earlier; or, if none has been established, the current directory will be assumed as the master directory.
Example:
PROJ \9705
Changes to subdirectory 9705 with in the previously-established master directory.

3) If path is only a back slash, the previously-established master directory and last-used project subdirectory are assumed.

Example:
PROJ \

4) If path is omitted altogether, changes to the previously-established master directory and lists the project subdirectories to choose from.

----------o----------

The PROJECT Command

6/97

The PROJECT command has two purposes:

1) It is used to define a project name of 1 to 8 characters. This name appears on the upper right-hand
corner of the screen and printouts. It is also used to form file names when they are omitted from certain commands. For example,
PROJ ABC
READ
This defines the project name as "ABC" and reads the Geometry File "ABC.GF". The project name is also carried in a system variable named PROJECT.

2) It can be used to manage subdirectories for project files. When used for this purpose, the first parameter always contains at least one back slash (\) -- except for one special case noted below.
It is assumed that there is a master project directory in which individual project directories are located. Optionally, there can be a subdirectory within the individual project directory which contains all of the files relevant to GHS. For example, suppose that the master project directory is C:\PROJECTS. Then, within this directory, there may be project subdirectories such as 9701, 9702, etc. Within each of these subdirectories there may be a subdirectory for GHS files, say GHSDAT. The directory structure would look like the following:
C:
PROJECTS
9701
GHSDATA
9702
GHSDATA
This structure could be created by the following two PROJECT commands:
PROJECT C:\PROJECTS\9701 (GHSDATA)
PROJECT C:\PROJECTS\9702 (GHSDATA)
Of course, it could also be created by operating system commands.
Once the directory structure has been established, the same PROJECT command can be used to change to the data directory. In other words, the new directory is created automatically if it does not exist, but in any case the result is to make the given directory the current or default directory.
If issued from the keyboard, the above commands will also prompt for a project name. If you do not want a project name, simply press Enter. You can also supply the project name as an additional parameter. For example,
PROJ C:\PROJECTS\9702 (GHSDATA) INTACT
This would create and/or change to C:\PROJECTS\9702\GHSDATA and also define the project name as "INTACT".
Another automatic feature when this PROJECT command is issued from the keyboard appears if there are any files in the project data subdirectory with extensions of ".RF", in which case their names will be listed on the screen before the prompt for the project name appears. This makes it easy to pick a project name by pressing the up arrow key and moving to the desired file before pressing enter.
Once the project name is defined in this manner, it is only necessary to give the EDIT (F4) or RUN (F5) command and press Enter to edit and Run the file respectively.

After a project master directory has been established, a particular project subdirectory can be selected interactively by giving the command in the following form:
PROJ C:\PROJECTS\
ote that the parameter must end in a back slash. This command first changes to the master directory C:\PROJECTS; then it lists the subdirectories and prompts for the subdirectory name. At this point the name can be typed in or the up arrow can be pressed to pick a project subdirectory from the list. If a new name is typed in, a new subdirectory will be created.

When any of these project directory operations are performed, the program remembers the name of the project master directory, subdirectory and data directory name (if any). Thereafter, these names are implied when omitted. For example,

PROJ \9702
Assuming that the previous commands have been issued, this will change to C:\PROJECTS\9702\GHSDATA.

Similarly, the command
PROJ \
will change to the last-used project subdirectory and (optionally) data directory.

And, finally, a special case is the PROJECT command without parameters:
PROJ
This changes to the last-used master directory and prompts for the project subdirectory to be entered.

The program "remembers" project directory names by recording them in a special file named GHS.PRJ which is located in the program directory. While it is not ordinarily necessary to do so, you can erase this file (causing the project directory names to be "forgotten") by the command,
PROJ OFF\

----------o----------

Applying CFR 171.055 for Sailing Vessels

3/99

In applying 46 CFR 171.055 for sailing vessels, the following method of doing the relevant calculations may be useful. The user should check it carefully and verify that it is operating correctly. It is recommended that the "/NOPRINT" parameter on the RA commands in macros "getangle" and "getarea" be deleted during this checking.

Since GHS/BHS cannot slice off the top of an RA curve, if you have a condition with the maximum less than 35 degrees, you will have to make two runs; the first to get the excessive area (by inspection of the RA-area curve) which you can then subtract from the area in the next run by giving it as the parameter on the "case" macro.

```
disk off
proj sail
`erase sail.gf
mac makesv
enter pm
create hull
ends 0 100
top 20
bot 0
out 15
margin 0
//
create sail
class sail
ends 25 75
top 120
bot 20
out .1
//
di
write
qu pm
/
if not fexist {project}.gf then .makesv else read macro getarea
`Sets the area veriable to the area under the RA curve.
`Assumes one LIMIT AREA in effect.
variable area
heel = 0
ra 0 5 /lim:att /noprint
set area = {limmarg} div 100 plus 1 minus {toparea}
/

macro getangle
`Sets the variable t to the angle of the given condition (RA0, DI, FLD).
variable t
limit(1) angle from 0 to %1 > 0
heel = 0
ra 0 10 /lim /noprint
set t = {limmarg}
/

macro gethz
`Computes HZ%1 according to CFR 171.055(g) usingf the given angle.
```

```
`The area variable is used for "l".
variable t1
set t1 = %1 times 2
set t1 = sin {t1} times 14.3
set t1 = %1 div 2 plus {t1}
set HZ%2 = {area} div {t1}
/

macro truncate
if {toparea} > 0 then exit
\ >>>> This is too small! The following does not apply.
\ You must determine the area to truncate from the following curve.
ra 0 2.5 ... 35 /area
set skip = 1
/

macro begin
`---- Check angle of maximum RA ----
variable skip, toparea
set skip = 0
set toparea = %1
.getangle MAX
\ Angle of maximum RA is {t}
if {t} < 35 then .truncate else set toparea = 0
if {toparea} > 0 then NOTE Trunced area = {toparea}
if {skip}<>0 then exit
\
`---- Get wind heeling arm ----
variable HZW
wind (pressure) = 0.001
hmmt wind /const
heel = 0
solve trim, tcg
hmmt report
set HZW = minus {FTCG}
tcg = 0
hmmt off
\ HZW = A x H / 1000 / W = {HZW}
\
/

macro hza
if {skip}<>0 then exit
variable ch,ch2,HZ,HZA,r
.getangle DI
\ Angle of deck immersion: {t}
heel = {t}
set ch = cos {heel}
set ch2 = {ch} times {ch}
tcg = 0
solve trim, tcg
set HZ = {FTCG} times {ch}
set HZA = {HZ} DIV {ch2}
tcg = 0
status
\ HZ = {HZ} HZA = {HZA}
```

```
set r = {HZA} div {HZW}
\ HZA / HZW = {r} (Should be greater than 1.0 protected, 1.5 exposed)
\
/

macro hzb
if {skip}<>0 then exit
variable HZB,r
fldpt on
limit(1) area from abs 0 to abs 60 or fld > 1
.getarea
.getangle fld
.gethz {t} B
\ Downflooding angle = {t}
\ Area = {area} HZB = {HZB}
set r = {HZB} div {HZW}
\ HZB / HZW = {r} (Should be greater than 1.1 protected, 1.7 exposed)
\
/

macro hzc
if {skip}<>0 then exit
variable HZC,r
fldpt off
.getangle ra0
limit(1) area from abs 0 to abs 90 > 1
if {t} > 90 then limit(1) area from abs 0 to ra0 or abs 120 > 1
.getarea
.gethz {t} C
\ Angle of vanishing righting arm = {t}
if {t} < 90 then NOTE This is not sufficient for exposed waters.
if {t} < 70 then NOTE This is not sufficient even for protected waters!
\ Area = {area} HZC = {HZC}
set r = {HZC} div {HZW}
\ HZC / HZW = {r} (Should be greater than 1.25 protected, 1.9 exposed)
\
/

`---- Set up condition ----
draft 13
vcg 12.5
solve weight, lcg
crtpt(1) "downflooding point", 50,10,30

macro case
.begin %1
.hza
.hzb
.hzc
/

.case 1.4 `<-- put area to truncate here if max is < 35 deg.

vcg = 11
.case 0
```

----------o----------

ACCURACY CONSIDERATIONS IN SELECTING STATION SPACING

3/96

For displacers (hulls), a minimum station density is enforced in order to prevent accuracy problems resulting from trapezoidal integration of the section area curve. The maximum allowed station spacing is 5% of the overall length, which, for normal area curves at maximum draft leads to displacement volume errors on the order of 0.1%. It is left to the user to decide whether greater accuracy is required. Decreasing the station spacing by a given factor can be expected to reduce the volume error by the square of that factor.

In some conditions of loading, the number stations which are actually immersed may be significantly fewer than the total number of stations, leaving the area curve to be represented by a lesser number of points. This, of course, results in more error in terms of the present volume, but not necessarily more error relative to the volume at normal draft.

Increasing the number of stations always improves accuracy, but at some point, the improvement obtainable by adding any more stations will be less than the errors from other sources, such as the approximations involved in the station curves themselves.

Centers and surface properties are also affected by station spacing. Waterplane properties, especially the longitudinal center and moment of inertia, are commonly less accurate than volumes and volume centers.

A particular source of inaccuracy in waterplane properties is in determining the outline of the interpolated end of a waterplane - - that area which occurs after the last station cut by the waterplane but before the end of the hull. This area is normally approximated as a triangle (corresponding to a waterplane which narrows to a point). However, square-ended waterplanes occur when the bottoms of the stations in the region of the waterplane ending are parallel to the waterplane (e.g. no deadrise in the bottom combined with a zero heel angle). In this case, the blunt waterplane ending is determined by extrapolating the width of the waterplane at the neighboring stations. Nevertheless, the accuracy of this procedure is not as good as that which results from adding stations (reducing the size of the area which must be determined by extrapolation).

This effect is most noticeable with barges which have no deadrise in one or both of the rakes. It may be necessary to use 10 or more stations within the rake in order to produce LCF and KM of sufficient accuracy to appear as smooth curves when plotted as a function of draft or displacement.

Tank volumes, centers and their surface properties are calculated using the same procedures used to find the displacement, center of buoyancy and waterplane properties of the hull. Therefore, the same accuracy considerations apply to containers which apply to the displacer parts.

The maximum station spacing for tanks is the same as for hulls. Therefore, a tank whose length is one 5% of the length of the hull could have as few as two stations. Depending on the shape of the tank, its level of loading and the attitude of the surface, the error involved could be quite substantial in terms of the tank itself -- though it would not necessarily be significant in terms of the overall ship.

With only two stations where their areas are very dissimilar, the volume error could be as high as 20%. Therefore, a good practice is to ensure that major components in all parts have at least four stations, reducing the error liability (due to station spacing) to about 5%.

If accurate tank properties are required independent of the tank's size relative to the size of the ship, then the overall length of the tank itself should be used as the guide in selecting the station spacing.
The usual process of creating a tank component within a hull involves the "FIT HULL" process which provides the resulting component with stations at the locations of intervening hull stations (in addition to its own end stations). If more stations are required, the SPACING statement can be included within the CREATE command.

User Variables and Variable Arithmetic

7/98

User variables have been available in the GHS command language for some time. Typically used in macros and run files, user variables allow certain operations to be performed in the GHS environment. With user variables, values not normally used or directly computed by GHS can be determined, reported, used to check compliance with a stability requirement, or passed on as a parameter in other GHS commands.

In addition to user variables, GHS utilizes several system variables. System variables make the current value for certain internal variables available to the user. Such system variables include the fixed weight and center, total weight and center, some tank information, displaced volume and center of buoyancy, project name and origin description to name a few. A complete listing of system variables is in the user manual under the variables command. These variables can be accessed and implemented the same way as user variables. The only difference is that system variables do not need to be declared and their values are automatically updated by GHS.

The first step to using user variables is to declare each variable. Users familiar with basic programming practices will recognize the elements involved in a GHS declaration. A declaration is made with the variable command. When issued with parameters, the variable command defines the type of variable(s) being declared. Two types are acceptable, real or string. If a variable type is not specified, the default is real. Optionally, the minimum and maximum value to be allowed with each can be given. For real variables, the min/max values given are real numbers, for string variables, the min/max values given are the minimum and maximum number of characters the variable is allowed. For example, to declare a real variable called 'angle' that will always be between 0 and 90 inclusive, and a string variable name 'list' that will always be "PORT" or "STBD"...

```
variable (real) angle:0:90
variable (string) list:4:4
```

Multiple variables of the same type can be declared on the same line.

If the variable command is issued without parameters, a list of all the system and presently defined user variables appears with their current values.
A declared variable is undefined until a value is assigned to it. This is done with the set or input command. The set command will assign a value to the variable when the command is executed. The input command, typically executed in a run file, will prompt the user to enter a value from the keyboard.

To demonstrate the use of variables, the following commands can be used to have GHS check compliance with the US Coast Guard Weather Criterion (46 CFR 170.170). These commands can be executed as they appear below or be part of a run file that checks several intact stability criteria of the subject vessel. As for any computation involving wind heel moments, the lateral projected area must be part of the geometry and if the angle to half freeboard is suspected to be limiting, the deck edge must be marked by defining a margin line in PartMaker.

```
clear
read fvw.gf
draft 6
solve we lcg
vcg 12
variable (real) gmreq, gmact
variable (read) windmom, tanang
variable (string) wxsat:0:3
```

The above block of commands sets up the waterplane in question. This could also have been accomplished by giving a weight and center and adding tanks and fixed weight loads. The variables to be used are declared. gmreq and gmact will be used for the required GMt found in accordance with 46 CFR 170.170 and the actual GMt computed by GHS respectively. windmom will be the total wind moment based on the lateral projected area and pressure and tanang will be the tangent of the limiting angle, 14 deg. or the angle to half freeboard, whichever is less. wxsat will be used to display the results after gmreq was checked against gmact.
The following macros should be used if several stability criteria are being checked within a single run file. The first clears any existing limits then sets an angle limit from 0 deg. to the lesser of 14 deg. Or angle of half freeboard. This single limit as defined will cause GHS to set the system variable limmarg to 14 deg. or the angle to half freeboard, whichever is less, whenever a righting arm calculation is performed and limits are evaluated.

```
macro 170170
limit off
limit title USCG Weather
limit angle from abs 0 to 14 or hf >0
/

macro 170calcs
set gmact={bmt} plus {vcb} sub {vcg}
wind (pressure) 0.005
`P=0.005+(L/14200)^2
hmmt wind /const
hmmt report
set windmom={hmmt}
hmmt off
rah /lim:at `notab
set tanang =tan {limmarg}
set gmreq={windmom} div {displ} div {tanang}
if {gmact} >={gmreq} then set wxsat="S" else set wxsat="Uns"
\\
\Actual GM = {gmact}
\46 CFR 170.170 Required GM = {gmreq}
\Weather Criterion found to be {wxsat}atisfactory
/
```

The above macro performs the steps necessary to check the criterion. This macro assumes weight and displacement equilibrium at the time the macro is invoked. The command, set gmact={bmt} plus {vcb} sub {vcg} sets the user variable, gmact, to the actual transverse GM using the system variables, BMt, VCB and VCG. When using variable arithmetic the space separator between operators is required. The curly brackets, { }, are used whenever a variable name is to be used. The only exception is the expression to the left of the equal sign in the set command and for the input command. The sole purpose of these two commands is to assign values to variables. Therefore GHS is expecting a valid variable name and the curly brackets are not required. The available operators are:
plus
add
minus
subtract
times
multiply
divide
power
sin
cos

tan
atan
abs
sqrt
trunc
left n
cap

The documentation for the set command in the user's manual describes each operator's function. Only the first two characters are significant for each. The order of execution is strictly from left to right.
If a user defined free surface moment is in effect, an additional variable will be needed to calculate the free surface correction and then this value will need to be subtracted from the above. Besides the declaration of a new variable, say fsa, the following line must be added.

set fsa={fsmmt} div {displ}

and then the calculation for gmact would be,

set gmact={bmt} plus {vcb} sub {vcg} sub {fsa}

The pressure commands sets the wind pressure to be used according to 46CFR 170.170(a). Be sure consistent units are used. Next the heeling moment due to wind is computed and reported for the current condition. The /const parameter causes the heeling moment calculated to be that at zero heel. The following set command takes the present value of the system variable hmmt, the current heeling moment, and assigns it to the user variable, windmom.
Finally, a righting arm calculation is executed so the system variable limmarg is set to the appropriate angle and the required GMt can be computed according to 46 CFR 170.170(a). Once the required GMt and actual GMt are known, these values can be compared with an if statement and the string variable wxsat set to report the results. Note that in the if command, the user variables in the condition statement are contained in brackets. Since these expressions are not always variable names, GHS needs to be signaled that variables are being used.

Once the above macros are incorporated into a run file, a line must be added to the run file to execute
these macros, for example,

.170170
.170calcs

Getting GHS to evaluate the US Coast Guard Weather Criterion is just one possible use of user variables and variable arithmetic. By making use of the features in the note command and the operators available with the set command, it is possible to customize GHS to perform hydrostatic calculations for almost any situation.

----------o----------

Evaluating Vessels for Weather Criterion (46 CFR 170.170)

6/98

GHS is capable of evaluating the stability of a vessel based on the Weather Criterion (46 CFR 170.170). This criterion assumes that the righting arm curve has the form of a sine curve and the heeling arm curve has the form of the cosine as shown in (1) and (2).

where

P = wind pressure

A = projected lateral area

H = the vertical distance from the center of the projected lateral area to the center of the underwater
lateral area.

W = displacement

phi = 14 degrees or the angle at which one-half the freeboard to deck edge is immersed, whichever is
less

The angle at which the heeling arm curve and righting arm curve intersect is the angle of equilibrium.
Therefore, at equilibrium

The Weather Criterion requires that (4) must be satisfied for each condition of loading and operation. Three LIMIT commands are required by GHS in order to apply this criterion.
The first LIMIT command assures that the angle of equilibrium occurs before 14 degrees or the angle at which one-half the freeboard to deck edge is immersed, whichever is less. It is defined as follows:

LIMIT(1) ANGLE from EQU to ABS 14 or HF > 0

The HF keyword (short for Half Freeboard) refers to the angle at which one-half the freeboard to deck edge is immersed. In this case, the angle from equilibrium to the lesser of 14 or HF must be greater than zero.

Before you can use the HF keyword, you must first mark the deck edge of the vessel. The deck edge is marked in Part Maker using the MARGIN command. For this criterion, the amount of the margin does not matter. You could use zero or any other value. For example,

```
modify hull\hull.c
margin 0
/
```

When you view the vessel using the DISPLAY command, you should see a line marking the deckedge.

GHS does not make the assumption that the righting arm curve is a sine curve -- actual righting arms
are calculated for each angle of heel. If only the angle of equilibrium is considered, it is possible to have
a righting arm curve which satisfies LIMIT(1) above but has very little righting energy up to the angle
or, in extreme cases, a negative GM at zero heel. In order to insure that the true righting arm curve
provides as much energy as would a sine curve, a second LIMIT command is required. It is derived
from (1) and (2) as follows:

The following LIMIT command can therefore be used to force the righting arm curve to be equal or better than the sine curve with regard to area (energy).

LIMIT(2) ABS RATIO from ABS 0 to ABS 14 > 0.492

An additional limit is required to guarantee that stability exists beyond the angle of equilibrium. This could be a measure of the range of stability or the residual area. For example, if the range of stability is to be at least 15 degrees beyond equilibrium the limit command would be,

LIMIT(3) ANGLE from EQ to RA0 > 15

To evaluate the stability of a vessel based on the Weather Criterion, you must also set the heeling moment. You can use the WIND and HMMT commands as follows:

WIND(PRESSURE) P
HMMT WIND /CS

where P equals the wind pressure as calculated according to 46 CFR 170.170(a). The values of A and H will be determined by GHS from the model and current waterplane. All superstructure that is to be included in the lateral area calculations must be modeled. If superstructure is to be included in the lateral area calculations but not in the buoyant volume of the vessel, it must be modeled as a SAIL part. These commands will then generate the heeling arm curve as defined in (2).

Following is a simple run of commands which can be used to perform a weather criterion analysis:

```
READ filename
REPORT
WEIGHT w, l, t, v
LIMIT(1) ANGLE from EQ to ABS 14 or HF > 0
LIMIT(2) ABS RATIO from ABS 0 to ABS 14 > 0.492
LIMIT(3) ANGLE from EQ to RA0 > 15
WIND(PRESSURE) P
HMMT WIND /CS
HEEL = 0
RA 0,2 ... 14 /LIM
```

----------o----------

Water on Deck

11/96

GHS provides two special tank types for the purpose of modeling the effects of the extra burden of water on deck due to waves.

The first, FLOODED PLUS, is an extension of the FLOODED type. It raises the flooded waterplane above the external waterplane by an amount such that the increased volume is equal to the volume indicated by the LOAD setting.

The other type is called DECK. It is similar to the DAMAGED type with LOAD = 0 and an additional head of water added to that of the external waterplane. The parameter /HW: must be included with the TYPE command in order to specify the value of the additional head.

Following is a run which demonstrates the use of these types to model the two methods of treating water on deck.

```
macro makeship
clear
enter pm
create hull
ends 0 100
top 20
bot 0
out 10
//
create deck.c
ends 15 85
bot 8
fit hull
//
display
write
quit pm
/
macro interp  `%1=x, %2=x1, %3=y1, %4=x2, %5=y2, %6=result var name
if %1<%2 then set %6 = %3 | exit
if %1>%4 then set %6 = %5 | exit
variable t
set t = %4 minus %1 times %3
set %6 = %1 minus %2 times %5 plus {t}
set t = %4 minus %2
set %6 = {%6} div {t}
/
macro wod
type = flood
solve
variable hw,f,v
variable (string) u
set u = "{wunit}"
unit mt
.interp {HEIGHT}, .3, .5, 2, 0, "hw"
.interp {hs}, 1.5, 0, 4, 1, "f"
set hw = {hw} times {f}
if %1="NEU" then type = deck /hw:{hw}
mac t
```

```
type = intact
heel = 0 | trim = 0
load = .5
solve depth
set f = {HEIGHT}
set v = {TVOLUME}
set f = {f} minus 0.1
load = height:{f}
solve depth
set v = {TVOLUME} minus {v} times 10
\\Deck area is {v} sq. meters\
set v = {v} times {hw}
contents = fw
load = weight:{v}
type = flood plus
//
if %1="POE" then .t
unit {u}
solve
/
macro stat
\With water on deck, wave height: {hs} meters  hw: {hw} meters\
status
/
macro ra
heel = 0
ra /area /nowarn
/

`===== Start of project commands  ======
`Get geometry
project testwod
if fexist {project}.gf then read else .makeship
report /nograph

`Set ship weight and C.G.
draft = 4.5
vcg = 5
solve weight, lcg

`Set point of damage
variable pod
set pod = "50a, 10s, 8"  `Point of damage, also used to determine freeboard.
refpt (hull) = {pod}

`Select deck to be flooded
tank deck.c
refpt = {pod}
type = flood

`Induce heeling moment
tcg = 0.5

\\==== Initial condition without water on deck: ====\
solve
status
```

```
`Set wave height
variable hs
set hs = 2.75 `Wave height in meters

macro case
page
\\%2 method\
.wod %1
.stat
.ra
/

.case neu "Northern European"
.case poe "Panel-of-Experts"

view
```

Probabilistic Damage: The IMO Subdivision Index for Cargo Ships

1/95

"Probabilistic damage" refers to a method for computing a measure of probable damage survivability which takes into account not only the vessel's stability when certain subdivisions of the ship are damaged but assigns probabilities to various extents of damage as well as to the survivability when so damaged. The products of these probabilities are summed over the various possible combinations of flooding which could occur from a single breach of the hull and the result is called the "Attained Subdivision Index".
In GHS terminology, a subdivision of the ship is called a "division". A division is a collection of one or more adjacent tanks/compartments. In essence, the procedure is as follows: 1) A certain load condition is set for the ship (weight and CG, possibly including loaded tanks).
2) An accumulator variable A (the Attained Index) is initialized to zero. 3) For a given subdivision of the ship, a probability of damage (P) is determined by the size and location of the division. (The longer the division, relative to the length of the ship, the higher its probability of damage). 4) A probability of survival (S) relative to the division is determined by examining the damaged stability characteristics with the division flooded. 5) The product, P*S is added to the attained index: A <-- A + P*S 6) Steps 3 through 5 are repeated for each division. 7) Steps 1 through 6 are repeated for additional load condition(s) and the attained indices for each are averaged. A certain minimum average Attained Index is required by the rules, based on the ship's size.

The actual procedure is somewhat more complicated, since it can look at fractions of a division being flooded independently, as well as multiple divisions being flooded together.
Note that it is inherent in this procedure that all subdivisions of the vessel need not be included in the analysis, as long as the Attained Index reaches the minimum required value.

How to Compute a Subdivision Index with GHS

The first step is to define the division geometry, since GHS needs to know what are considered divisions. It does not assume that each tank and compartment is an independent division. Normally, each double bottom
tank should be included with at least one other compartment, rather than being a division by itself. For defining divisions, use the command DIVISION (n) = TankList [/WING:b] [/HBHD:v] which assigns a unique number n to the division which involves those tanks listed by name. If the division includes a wing tank, then the /WING parameter should be used along with the wing breadth b as defined in the IMO rule. If a horizontal bulkhead is present above the waterline and capable of limiting the flooding when not damaged, its height relative to the baseline can be indicated with the /HBHD parameter. When performing the probabilistic damage procedure, GHS sorts the divisions into order according to their forward longitudinal locations. It then proceeds to use the divisions from bow to stern. After completing the
survivability analysis using the first (forwardmost) division, it takes the next division which starts at or after the aft end of the present division. Hence, any overlapping division will be ignored. For this purpose, the nominal forward and aft ends of the division are used. The nominal ends are the same as the actual ends taken from the geometry unless the /FWD and /AFT parameters are used with the DIVISIONS command to set nominal ends at other locations. By this means, divisions which do overlap can be made acceptable. See the DIVISIONS command in the GHS User's Manual for more details. After all of the divisions have been defined, the Attained Subdivision Index in the current loading condition may be obtained by the command DAMSTAB [(DivList)] [/L: L1,L2] [/B: B] [/H: Hmax] /SDIC

which computes and displays the probability of damage and probability of survival for each damage case as well as the attained index. If DivList is present, it specifies the divisions used; otherwise, all of the defined divisions are used. If the /L parameter is present, it specifies the

terminal points of the Subdivision Length; otherwise, the overall model length is used. If the /B parameter is present, it
specifies the Subdivision Breadth; otherwise, the maximum breadth of the model is used. If the /H parameter is present, it specifies the "maximum possible vertical extent of damage above the baseline";
otherwise, the same is computed as a function of the Subdivision Length.
Following is an example of a subdivision index Run File:

```
PROJECT CARGO1
READ
REPORT

DIV(1) workspc.c, fwctk.c, apt.c /AFT:107.3
DIV(2) no2dot.s, btmineng.c, enginrm.c /FWD:82.9
DIV(3) hold5.c, no4wbt.s, void5.s /AFT:82.2 /FWD:69.6
DIV(4) fwt.s, void4.s, no4wbt.s, hold4.c /AFT:69.6 /FWD:56.3 /WING:3.0
DIV(5) no3wbt.s, no2wing.s, void3.s, hold3.c /AFT:56.3 /FWD:43. /WING:3.0
DIV(6) no3wbt.s, no1wing.s, void2.s, hold2.c /AFT:43. /FWD:29.7 /WING:3.0
DIV(7) no2wbt.s, void1.s /AFT: 29.7 /FWD:20.6
DIV(8) hold1.c, no1wbt.c, no2wbt.s, void1.s /AFT:20.6 /FWD:9.4
DIV(9) thrstrm.c
DIV(10) fpt.c /FWD:-4.80
DIV
MACRO case
  TRIM = 0
  HEEL = 0
  DRAFT = %1
  VCG = %2
  SOLVE WEIGHT, LCG
  DAMSTAB /SDIC
/

.case 6.5, 7.13
.case 4.684, 6.564

QUIT
```

----------o----------

Interfacing a Digitizer with Section Editor

3/95

The SE program interfaces with most digitizers through ADI drivers. The driver is a small memory-resident program which stands between the digitizer hardware and an application program such as SE. The ADI standard was established by AutoDesk (manufacturer of AutoCAD) and is therefore very commonly used. Most likely your digitizer came with an ADI driver file. There are two forms of drivers: "Real Mode" and "Protected Mode". SE uses the Real Mode form. For example, most mouse drivers are in Real Mode form. Typically you install a Real Mode driver by executing an .EXE file. Some drivers are supplied as a .SYS file which must be installed by including a DEVICE statement in the CONFIG.SYS file which references the driver's .SYS file. When you install the driver you typically give a parameter indicating which serial port the digitizer is attached to. You may also have to specify the baud rate, etc., but usually the driver will sense that automatically. The exact details of the parameters you need to use when installing the driver should be provided by the documentation which came with the digitizer. If your digitizer is connected to serial port #1, you may find that the driver can be installed successfully without using any parameters. If it is connected to another port, the port number is commonly conveyed using only a slash followed by the port number. For example port #2 would be:

drivername /2

Real Mode ADI drivers communicate with the application through a "software interrupt vector" which is identified by a particular "interrupt number". Since AutoCAD uses interrupt 121 (79 hexidecimal) this is the interrupt number which the driver will most likely assume by default. Likewise, SE assumes interrupt 121. SE and the ADI driver must both be using the same interrupt number in order to communicate.

SE supports two kinds of digitizers directly, without the need of a driver. These are the Summagraphics MM 1201 series and the Calcomp 9100 series. When using SE with either of these digitizers and without a driver, you must set the communication parameters of the serial port to agree with the settings used by the digitizer. This is done by means of the MODE command in DOS. For example: MODE COM1: BAUD=9600 PARITY=ODD DATA=8 STOP=1

sets the communication parameters of serial port #1 to 9600 baud, etc. Once set, these parameters will remain in effect until changed by another program or until the computer is restarted. Once you have established the parameters you will be using, you can make a little batch file with the proper MODE command in it. Thereafter, you can set the communication parameters merely by typing the name of the batch file.

----------o----------

Downflooding Points

4/95

Applies to GHS, BHS & BHS/Yacht version 6.20 and later

The CRTPT Command:

GHS maintains a list of "Critical Points" which are not associated with any particular part of the vessel model, but are used as points of down-flooding and other purposes relating to the vessel as a whole. Critical points may be specified through Part Maker in the model-building stage. They may also be specified and changed with the main program. A Critical Point consists of a name and a location (longitudinal, transverse and vertical coordinates). It also has two additional attributes: Symmetry status and Flooding status. The Symmetry status of a Critical Point indicates whether the point is to be regarded as the single point represented by its coordinates (asymmetrical) or as actually two points, one symmetrically opposite the other (by negation of the transverse coordinate). By default the Symmetry status is asymmetrical. To make it symmetrical the following form of the CRTPT command is used (in the Main Program, not Part Maker): CRTPT ... /SYMMETRICAL

Any use of a critical point which implies only one point (eg. the HEIGHT command) uses only the point as given and ignores the Symmetry status. The Flooding status has three states: Flooding, Tight and Noflooding. Flooding means that the point will be regarded as a downflooding point as referenced by the FLD keyword in the LIMIT command and the DAMSTAB command. Tight is similar to flooding but it applies only when the vessel is at the initial equilibrium angle. At other heel angles the Tight critical points are considered to be nonflooding. Noflooding means that the critical point is ignored as a flooding point. The Flooding status can be set in the main program by appending one of the parameters /FLOOD, /TIGHT or /NOFLOOD to the CRTPT command. The default is Flooding.

The FLDPT Command:

The FLDPT command works in conjunction with the CRTPT command. It allows the Flooding status of any or all Critical Points to be conveniently changed. It has the following form: FLDPT [(n)] ON | OFF [/TIGHT]

n refers to one of the Critical Points. If it is absent, all Critical Points are implied. ON turns on the Flooding status (Flooding or Tight, depending whether the /TIGHT parameter appears). OFF sets the Flooding status to Nonflooding.

Effects of Flooding and Tight Critical Points

RA, MAXVCG and SOLVE MAX commands:

The procedure invoked by these commands in turn refers to the stability criterion defined by LIMIT commands. When the FLD keyword is referenced by a LIMIT, it implies the downflooding points represented by Critical Points with Flooding status either Flooding or Tight. However, any Tight Critical Points are only considered when the vessel is in equilibrium.

CC Command:

This command considers only Critical Points having Flooding status.

DAMSTAB Command:

Like the RA command, DAMSTAB considers Critical Points having both Flooding and Tight status, but the Tight points are ignored except at the initial equilibrium.

DIVISION Command:

The DIVISION command can reference a Critical Point when the /FLD parameter is used. For example, DIVISION ... /FLD: 2

associates Critical Point 2 with the division when it is being defined. It also sets the Critical Point to Flooding status in case it was not so designated before. When a Critical Point is associated with a division in this manner it prevents that point from being considered when that division is flooded during the DAMSTAB command process.
NOTE: MAXVCG, SOLVEMAX, DAMSTAB and DIVISION are not available in BHS or BHS/Yacht.

CC is not available in BHS/Yacht.
----------o----------

Using Free Surface Moments in Stability Calculations

4/95

Applies to GHS & BHS versions 6.36 and later

A partially-filled tank reduces the hydrostatic stability of the ship by virtue of the shifting of the fluid within the tank. GHS and BHS account for this "free surface" effect by actually calculating the new C.G. of the fluid with each change of trim and heel.

Another method of representing the free surface effect is to elevate the ship's center of gravity by a suitable amount. This simplifies the calculation of righting moments as a function of heel since the tank's contribution to the center of gravity is considered to be fixed. The amount by which the C.G. is elevated may be chosen such that the
additional righting moment produced by a small change of heel is the same as would be produced by the shifting of the tank's contents. This
elevation of the C.G., multiplied by the weight of the ship, is called the free surface moment, or FSM. The primary disadvantage of using the FSM is that it does not accurately represent the tank's effect on stability beyond a small increment of
heel, since the FSM itself can be very different at different heel angles.

Applications of the FSM

In the past, the primary advantage of using the FSM was its relative simplicity, and although the availability of high-speed computers has made that less of an issue today, there remain some applications where the FSM is still a useful shortcut.
One such application uses maximum FSM values to represent the free surface even in a case of loading where the true FSM is less than
maximum. The intent is to make a few sample cases representative, in a worst-stability sense, of all the various loads which would occur during normal operation. Another application where the FSM is necessary is in the use of precomputed maximum VCG data for a quick stability check. In order to use maximum VCG data to assess the stability of a particular load case, the effect of slack tanks is conveniently and quickly represented by the FSM. The present VCG is increased by an FSM adjustment before being compared with the maximum VCG. GHS

Facilities for using FSM

In order to accommodate these applications, GHS associates two FSM functions with each tank. One function is used for load factors between zero and just under 95%. The other is used with loads from 95% to 100%. Each FSM function is allowed to have one of three forms: 1) a constant value; 2) a constant value except at zero and 100% loads where the
value becomes zero; and 3) a variable equal to the true FSM value at each particular load. GHS allows the value used by the first two forms of the FSM function to be either specified directly by the user or taken from the FSM present in a particular load at a particular heel and trim. A means of finding the load which has the maximum FSM at a particular heel and trim is available. In addition, GHS provides for a minimum FSM -- a "floor" value which becomes the effective FSM when it is greater than the FSM sum from the
tanks. In addition to the overall FSM floor, individual FSM floors can be designated for each of the various descriptions of tank contents. Assigning FSM functions to a tank is done by means of the command which has the form, FSMMT [(tanklist)] = f1 [,f2] [/UNCONDITIONAL]

tanklist is a list of the names of the tanks to be affected. f1 is the function which applies when 0.0 ó load < 0.95; f2 is the function which applies when 0.95 ó load ó 1.00.
If f2 is not specified, it becomes identical to f1.

The variable, or true-FSM form of the function is specified by the keyword TRUE. This is the "default" form of the FSM functions before the FSM command is issued.
Three options are available in specifying the constant form. One is simply to give the FSM value directly. The other two use keywords:
PRESENT uses the present FSM value (at the present load, heel and trim).
MAX first finds the maximum FSM value (of all loads at the present heel and trim) and makes that the present load. It then takes that FSM value for the constant. This cannot be used for f2 unless f1
is also MAX.
The /UNCONDITIONAL parameter modifies the constant function forms which, by default, are actually constant only when the load is greater
than zero and less than 1.0. This parameter makes the constant absolute so that the same FSM value is used even in the empty and full conditions.
Because the FSM function does not always represent the true FSM (except in the variable or TRUE form), the value given by the function is
called a "formal" FSM value.
In the case of flooded and frozen tank types, the FSM value is regarded as zero, even if a constant formal FSM has been assigned.
The STATUS /FSM command shows the FSM values yielded by the FSM functions in the current condition and marks with an asterisk those which depart from true FSM values. STATUS /TRUEFSM shows true values for all tanks
regardless of what the formal values might be.
The total FSM in any condition is determined by summing the FSM values of all tanks.
The means by which a lower bound is placed on the total FSM is the FSMFLOOR command. This command can also be used to place minimum
values on the total FSMs of all tanks sharing the same contents. It has the following form,

```
FSMFLOOR ["contents"] = FSM | n
FSMFLOOR OFF
```

Without the "contents" parameter this command sets the overall FSM floor. With the "contents" parameter a floor value is established for all those tanks which have the indicated contents.
The keyword FSM specifies that the present total FSM is to be assigned as the lower bound.
n sets the lower bound to the given value.
The OFF parameter sets all fsmfloor values to zero.
GHS can perform an FSM-like modification to the C.G. during a righting-
arm calculation while still calculating the actual C.G. shifts within tanks. This feature is enabled through the /EXTRAFSM parameter on the RA and SOLVE MAXVCG commands. It uses the difference between the formal and true FSM (but not less than zero) to raise the C.G.

Updating Old FSM Commands

GHS versions prior to 6.16 used a command called FSM (alias USERFSM) and the parameters /MAXFSM and /USERFSM on various other commands. These have been deleted since the new FSM command together with the FSMFLOOR command accomplish the same purpose more directly. Following are examples where the usage has changed.
Old method for applying a fixed overall FSM:
USERFSM = n and /USERFSM on various commands.
New method:
FSMMT (*) = 0 FSMFLOOR = n and /FSM on the same commands where /USERFSM appeared.
Old method for applying maximum FSM values:
STATUS /MAXFSM or STATUS /MAXFSM: tank list and /MAXFSM on various other commands.
New method:

FSMMT (*) = MAX or FSMMT (tank list) = MAX /UNCONDITIONAL
FSMFLOOR OFF
and /FSM on the same commands where /MAXFSM appeared.

/FSM and /TRUEFSM Parameters

In general, the /FSM parameter refers to the formal FSM value while the /TRUEFSM parameter refers to the true FSM in the current condition. The /MAXFSM and /USERFSM parameters are no longer used. Following is a summary of the FSM parameters now available on various commands.

GHS: /FSM - Use formal FSM values.
/TRUEFSM - Ignore formal values and use true values instead.
Default: Same as /FSM.

LOAD EDIT: See GHS

MAXVCG (without primary parameters): See GHS

RA: /FSM - Cause the tanks to be frozen and the C.G. to be raised perpendicular to the waterplane according to the formal FSM. /TRUEFSM - Same as /FSM except uses true FSM values.
/FSMEXTRA - Keeps tanks liquid but raises the C.G. according to the difference between the formal and true FSM. Default: Keep tanks liquid and do not change C.G.

ROLL PERIOD: Same as GHS except the default is /TRUEFSM.

ROLL IMO: See GHS

STATUS: /FSM - Use the formal FSM in the TANKS and WPL sections. /TRUEFSM - Use the true FSM in the TANKS and WPL sections
Default: Do not show FSM in the TANKS section; use the true FSM in the WPL section.

SOLVE MAX: See RA

SOLVE (other): Neither /FSM nor /TRUEFSM used.

USERFSM: Discontinued

VCG MAX: See GHS

Applications

US Code of Federal Regulations 46-170.285: Intact stability using maximum FSMs. Allows tank LCG shifts to contribute to initial trim. Forces initial heel to zero by adjusting TCG. Raises C.G. normal to waterplane. Uses maximum FSM values derived at zero heel and zero trim for all tanks. Always counts at least "Big Consumables" FSM. Only counts other consumables FSMs if they exceed "Big Consumables" for each consumable type.
Note: This is not the only interpretation of this regulation.

```
MACRO FLOOR FSMFLOOR OFF FSMMT (*) = MAX STATUS TANKS /FSM
\Determine by inspection the "Big Consumables" from above FSM values.
 FSMMT (*) = 0 LOAD (*) = 0 FSMMT (Big Consumables) = MAX FSMFLOOR "*" =
FSM STATUS TANKS /FSM `Documents the derivation of the floor FSM /

 MACRO COND DELETE ALL WEIGHTS LOAD (*) = 0 .LOAD%1 /
```

MACRO CALC HEEL = 0 | TRIM = 0 SOLVE TRIM, TCG STATUS /FSM `Documents the current condition & FSM GHS RA /FSM /

HEEL = 0 | TRIM = 0 .FLOOR FSM (*) = MAX WEIGHT ...
.COND 1 .CALC .COND 2 .CALC ...

For a more realistic calculation in the spirit of 170.285, substitute /FSMEXTRA for /FSM on the RA command.
US Code of Federal Regulations 46-170.290 by (c)(1) - Damage stability using FSM at 5 degrees heel.

MACRO DAMCALC TANKS = %1 TYPE = FLOODED HEEL = 0 SOLVE STATUS %2 ANGLES = * RA %2 TYPE = INTACT /

MACRO FSM HEEL = 5 | TRIM = 0 FSMMT (*) = PRESENT /

HEEL = 5 | TRIM = 0 .FLOOR WEIGHT ... .COND 1 .FSM .DAMCALC "Damaged Tanks" /FSM .COND 2 .FSM .DAMCALC "Damaged Tanks" /FSM ...

US Code of Federal Regulations 47-170.290 by (c)(2) - Damage stability using moments of transference.

WEIGHT ... .COND 1 .DAMCALC "Damaged Tanks" .COND 2 .DAMCALC "Damaged Tanks" ...

----------o----------

Introduction to Macros

4/95

(Applies to GHS & BHS)

"Macros" are found in various kinds computer programs. The "mainline application" programs such as word processors, spread sheets and data-base programs often provide something called a "macro" facility. "Macro" literally means "large", and in computer jargon it generally refers to a command which may be made up of a large number of other commands.

Most of the macro facilities found in application programs are built-in versions of what was a common utility a few years ago: the "keyboard macro" program. They function basically by recording keystrokes, allowing you to collect the keystrokes as a named "macro" and "play them back" at a later time by invoking the macro name.

However, such "macro" facilities are awkward and of limited use compared to an older tradition in which the macro is an extension of a programming language. Most assembly languages have macros of this type as do a few higher-level languages. Even DOS, which is itself a rudimentary language, has a macro facility known as the "batch file". It is this type of "language-based macro" which GHS implements; and in the following discussion, the term "macro" will be used to mean this kind of macro.

The concept of the macro is very simple: a macro is a collection of commands which, when the macro name is invoked, causes those commands to be executed. This alone is a powerful thing; but its power is vastly increased when "parameter substitution" is performed.

If you know a programming language such as FORTRAN, C, Pascal or a modern version of BASIC, you are familiar with the concept of the "subroutine" (or "subprogram" or "procedure", depending on the terminology of the particular language). These all have the ability to "pass parameters" which are referenced as symbols (usually variable names) within the subroutine. Although you can also "pass parameters" when invoking a macro, the interpretation of the parameters in macros is a little different.

When you define a macro, you are simply storing a collection of text. The system does not require that it make sense at the time it is defined. Therefore, your parameter substitution may take place anywhere within the macro. You can even supply whole commands as parameters. This leads to an extremely broad range of possibilities and is what makes the macro so powerful. However, one of the liabilities of the macro, compared with the subroutine, is that the system cannot warn you of syntax errors within the macro until it is actually executed.

In GHS, the form of a macro definition is

```
MACRO name
body
/
```

where "name" is an arbitrary name by which the macro is thereafter referenced and "body" is one or more lines of text. The single slash on a line by itself marks the end of the macro definition. If a macro by the same name already exists, it is replaced by the new definition. If "body" is missing, it is a "null" macro and the definition has no effect except that if a macro by the same name does exist, that macro is "erased" -- this is how you delete a macro.

Other than storing a series of text lines, the MACRO command does nothing. Therefore, it may appear anywhere in a command stream. It is usually placed in a Run File.
Making use of a previously-defined macro simply requires the name of the macro preceded by a "dot" or period. Thus, if a macro named XYZ
has been defined,

```
.XYZ
```

will cause the text in its "body" to be executed as a series of commands.
If parameters are involved in a macro definition, they are represented by the appearance, in the macro body, of the 2-character string "%n" where "n" is a single digit 1 through 9. This is the same convention which is used by DOS in batch files. For example,

```
MACRO MSDRAFT
  DRAFT = %1 @ MS
/
```

defines a macro named MSDRAFT which contains one line of text. The "%1" is interpreted as "parameter #1 goes here". It's sometimes called a "dummy" parameter. If you execute this macro by saying

```
.MSDRAFT 12
```

then DRAFT = 12 @ MS

is the actual command which the system will receive.

Consider another example:

```
MACRO LOAD
  TANK=%1
  TYPE=INTACT
  CONTENTS=%3
  LOAD=%2
/
```

This might be executed by

```
.LOAD FO1.P, .95, SW
```

yielding the command sequence

```
TANK=FO1.P
TYPE=INTACT
CONTENTS=SW
LOAD=.95
```

Note that even though the macro is named LOAD, the same as the name of an intrinsic command, there is no confusion since a macro invocation is distinguished by the leading "dot".

Also note that the dummy parameters can occur in any order within the body of the macro definition. At execution time, the order in which the actual parameters are given determines their identification with the %1, %2, etc. within the macro body.
If there are more dummy parameters in the body than there are actual parameters given at the execution, the missing parameters will be considered to be empty, and the result of the substitution is that the extra dummy parameters are removed. For example,

```
MACRO WT
  TANK= WINGTK%1%2
/

.WT 3, .S  yields  TANK= WINGTK3.S
```

while

```
.WT 3    yields  TANK= WINGTK3
```

A very important ability of GHS macros is that they can invoke other macros. For example,

```
    MACRO LDWT
  .WT %1, *
  TYPE= INTACT
  LOAD= %2
  CONTENTS= FO
/

MACRO LDWT1-3
  .LDWT 1, %1
  .LDWT 2, %1
  .LDWT 3, %1
/
```

and the execution,

```
.LDWT1-3 .98
```

would put 98% fuel oil in three (pairs of) tanks.

As another example, consider the following macro:

```
MACRO HEADING
  PAGE
  \****** Condition: %1 ******\
/
```

This would work fine if you passed it a single word, such as

```
.HEADING DEPARTURE
```

But what if you wanted to use two or more words? If you threw some extra dummy parameters into the definition (eg."*** Condition: %1%2%3 ***"), there would be no spaces between the words; "*** Condition: %1 %2 %3 ***" would give you an extra space or two if you happened to use less than three words.
The better solution is to enclose a multi-word parameter in quotation marks. For example,

```
.HEADING "Wing Tanks Damaged"
```

would take all three words, strip off the quotation marks and then substitute them all for %1. Using the IF control command, you can make a macro do different things, depending on some variable or parameter. For example, you can check that the proper number of parameters is supplied at execution time:

```
MACRO LOAD
  IF "%3"="" MESSAGE "Parameter missing! | EXIT
  TANK= %1
  TYPE= INTACT
  CONTENTS= %3
  LOAD= %2
/
```

Another powerful feature of macros is their ability to create or "spawn" other macros. This is often used when implementing menus in GHS. For example,

```
MACRO WSET
  MACRO ESC
    EXIT MAIN
  //
  MENU " Weight setup " %1
  \
  \A\.ADD\Add a weight item
  \D\.DEL\Delete a weight item
/
```

spawns a little macro named ESC prior to executing the MENU command. Notice that MACRO ESC is treated as ordinary text when WSET is defined, with the exception that one of the slashes is removed from its terminating line. Thus, when WSET is executed, it right away presents the system with a macro definition.

Incidentally, when a GHS process is aborted by your pressing the Escape key, it looks for the presence of a macro named ESC, and if it finds
one it executes ESC instead of returning to the normal input stream.

When a macro is defined within a macro as in the example above, you must be careful to avoid unintended parameter substitution in the inner macro. Actually, you cannot avoid parameter substitution because every %n within the macro is replaced when the macro is used. However, you can use a little trick to get what you want anyway. For example, If the inner macro needs one parameter, you would like it to retain a %1 after parameter substitution has taken place. This can be done by putting %%91 in place of the %1, assuming that the parent macro will always have less than 9 parameters. The %9 is replaced by nothing, leaving the %1 you wanted.

Although these brief examples were selected to demonstrate various features of GHS macros, the primary overriding purpose in applying macros is to reduce repetition. Whenever you find that you have to repeat a certain sequence of commands several times, it is almost always better to construct a macro which contains the sequence and then execute the macro. This reduces the repetition within the text of the Run File and thereby reduces the chance of making an input error. While macros can be placed in any Run File (and you will find that most Run Files are more compact and easier to check when they use
macros) it is sometimes convenient to organize general-purpose macros into separate "Library Files" so that they may be more conveniently used
in any job. In other respects, a Library File is no different from any other Run File. When executing the GHS program from DOS, you can
indicate that you want to have it read a given Library File by including the file name after the "/L" parameter.

For some people, the best way to learn about using macros is to simply experiment with using them. Others learn better by studying examples. Examples of macro Library Files can be found in the GHS distribution files which have the file name extension ".LIB".

----------o----------

Building a Swath

4/95

Part Maker is capable of assembling components into complex models. The following example is a run file which builds a SWATH starting from two files, STRUT.GF and HULL.GF which contain single-component models of the strut and the pontoon hull, respectively (both are assumed to be symmetrical about their own centerplanes). It is assumed that the part name on each file is HULL so that one of them will have to be renamed before the other file is read.

The techniques demonstrated here can be extended to much more complex situations.

```
READ FILE          `This file contains one strut as a part named HULL.

CREATE TEMP              `In order to avoid a part name conflict we now  CLASS HULL
`effectively rename the strut part from HULL to TEMP.
 COMPONENT TEMP
 SHAPE HULL\HULL
/
DELETE HULL

READ HULL.GF       `Now we read the file containing the hull.

CREATE HULL\STRUT    `Just to make things more tidy, move the strut over
 SHAPE TEMP\TEMP      `to the HULL part.  FIT HULL
/
DELETE TEMP        `The TEMP part can now be deleted.

CREATE SWATH             `Let's call the part containing the final assembly   CLASS HULL
`"SWATH".
 COMPONENT DECK      `Create the deck component.
 ENDS -60,60
 TOP 30
 BOTTOM 25
 OUTBOARD 28
 COMPONENT S-HULL    `Create the starboard hull component.
 SHAPE HULL\HULL
 VECTOR 0,20,0       `This moves the CL component S-HULL.C over to the side.
 COMPONENT P-HULL    `Similarly for the port hull.  SHAPE HULL\HULL
 VECTOR 0,-20,0
 COMPONENT S-STRUT   `Same idea for the struts.  SHAPE HULL\STRUT
 VECTOR 0,20,0
 FIT DECK            `But make sure the struts don't overlap the deck.  COMPONENT P-STRUT
`Similarly for the port strut.
 SHAPE HULL\STRUT
 VECTOR 0,-20,0
 FIT DECK
/
DELETE HULL        `Now get rid of the original HULL part.

DISPLAY
WRITE SWATH.GF
QUIT
```

----------o----------

Tank Modes and Types

4/95

Applies to GHS & BHS versions 6.20 and later

GHS models the various ways in which tanks can behave by assigning to each tank a Type through the use of the TYPE command. The LOAD and
CONTENTS commands are used to set the volume of fluid within the tank and the density of the fluid, respectively.
The most common and simplest tank type is INTACT. An Intact tank contains a certain volume of liquid and the surface of the liquid is
maintained such that it lies in a plane parallel with the external waterplane.
Other tank types may have variable volumes, but there is always a Nominal volume associated with each tank. For an Intact tank, the actual volume is the same as the Nominal volume.
Nominal volumes are always set by the LOAD command and remain as set until changed by another LOAD command.
Since some tank Types involve complex behavior, it is useful to refer to the Mode in which a tank is operating. Following is a list of the tank Modes and Types.

Tank Modes

Constant-Volume Mode --
Volume: Equal to the Nominal volume Surface: Parallel to the external waterplane
Weight: Adds to the ship's total weight Free surface: Adds to the total FSM

Frozen Mode --
Volume: Equal to the Nominal volume Surface: Fixed at a prescribed orientation Weight: Adds to the ship's total weight Free surface: None

Spilling/Filling Mode --
Volume: Varies Surface: Passes through Tank's Ref. Point & Parallel to external WPL.
Weight: Adds to the ship's total weight Free surface: Adds to total FSM
Flooded Mode --
Volume: Varies Surface: Coincident with external waterplane
Weight: Subtracts from ship's buoyancy Definition: Balanced
Internal and external pressures are equal at tank's Ref. Pt. External pressure is determined by Ref. Pt. depth.
Internal pressure is determined by the gas at top plus column height. Level within tank not allowed to go below Ref Pt.

Balanced Mode Sealed --
(Pressure of gas at top is inversely proportional to void volume.) Volume: Varies; Nominal volume is where pressure = 1 atmosphere Surface: Parallel to external waterplane Weight: Adds to ship's total weight Free surface: Adds to total FSM

Balanced Mode Vented --
(Pressure of gas at top constant at 1 atmosphere) Volume: Varies Weight: Subtracts from ship's buoyancy

Tank Types

Intact Type --

Unconditional: Constant-Volume Mode
Frozen Type --
Unconditional: Frozen Mode Surface orientation is set parallel to external waterplane at time of TYPE or LOAD.
Spilling Type --
Ref Pt above interior level: Const Volume Mode Ref Pt at interior level: Spilling/Filling Mode
Ref Pt below interior level: never
Bubble Type --
Unconditional: Balanced Mode Sealed
Damaged Type --
Ref Pt above water: Same as Spilling Type Ref Pt below water:
Same density as external: Flooded Mode Different density: Balanced Mode Vented
Flooded Type --
Unconditional: Flooded Mode

Side Effects of Type Changes

When the tank Type is set by the TYPE command, Nominal volume remains unchanged. Contents also remains unchanged except as follows:
TYPE FLOOD sets Contents density equal to external density and Contents description to "SEA".

Changing Type from FLOOD to another Type restores the original Contents density and description which were in effect prior to the TYPE FLOOD command.
(Note: These side effects did not exist in versions prior to 6.20)

Equations of Pressure Balancing

The tank Types BUBBLE and DAMAGED both involve determining the level inside the tank such that the pressure at the tank's Reference Point is
the same inside the tank as it is outside the tank. The tank's Reference point is set by the REFPT command and normally would be located on the
tank's actual boundary, though it can, in fact, be located anywhere.
Ps is the pressure at the surface of the liquid in the tank. Pr is the pressure at the Reference Point. Pc is the pressure contributed by the column of liquid in the tank from its surface to the Reference Point.

$$Pc = ht * C * SGt$$

$$Pr = 1 + d * C * SGs$$

where
ht is the height of the column
d is the depth of the Reference below the external waterplane C is the pressure per unit depth of fresh water in atmospheres
SGt is the specific gravity of the tank contents
SGs is the specific gravity of the sea water

In order to balance the pressures,

$$Pr = Ps + Pc$$

In the Balanced Mode Vented,

$$Ps = 1 \text{ atmosphere.}$$

Therefore,

$$ht * C * SGt = d * C * SGs$$

$$ht = d * SGs / SGt$$

In the Balanced Mode Sealed,
Nominal Volume is defined such that: Ps = 1 atmosphere at Nominal Volume

Load is defined as:
Load = Actual Volume / Maximum Volume

Since for a gas, pressure * volume is constant, Ps = (1 - Ln) / (1 - La)

where Ln is the Nominal Load
La is the Actual Load
Therefore,
1 + d * C * SGs = (1 - Ln) / (1 - La) + ht * C * SGt

ht = C0 * (C1 - C2 / (1 - La))
where C0 = 1 / (C * SGt) C1 = 1 + d * C * SGs
C2 = 1 - Ln

This shows that ht is a function of La which is also a function of ht and the geometry of the tank. Thus an intuitive procedure is applied to find the solution.

Setting the Bubble Pressure

In the case of a BUBBLE-Type tank, the LOAD command can also set the pressure at that load by means of the /PRESS parameter. For example,
LOAD = 0.75 /PRESS = 1.1

sets the load and pressure such that the pressure would be 1.1 atmospheres at 75% load in the tank.
When the LOAD command is used without giving a value, it displays the present load as well as pressure.

Liquid-Loss Calculations

The loss of liquid when one or more tanks are ruptured at known locations can be accurately calculated by using the DAMAGED type. For example,
STATUS TANK name
REFPT = damage location
TYPE = DAMAGED `(repeat above three commands for additional tanks) SOLVE
STATUS
The difference between the load in the tank(s) as of the first STATUS and the second STATUS is the amount of liquid lost.
By using a suitable macro and variables, this process can be automated for more convenience. For example,
MACRO SPILL `Uses System variable TVOLUME to get VOL before & after damage.
`Assumes that Reference Points have been set at points of damage.
VARIABLE VOL TYPE (*) = INTACT SOLVE TANKS %1 SET VOL = {TVOLUME}
TYPE = DAMAGED SOLVE SET VOL = {VOL} MINUS {TVOLUME} \ Oil spilled from
{PNAME}: {VOL} CUBIC {LUNIT} /
Then
.SPILL "tank list"

shows the volume lost.

True Downflooding

Using the DAMAGED tank type it is possible to have a tank automatically flood when its point of downflooding is reached. Such a tank behaves as
a spilling tank (or an empty tank if its Nominal load is zero) while the Reference Point is above water and a flooded tank when the Reference
Point is below water. If the heel angle is such that the Reference Point is initially above water and then increased until it is below the surface,
the tank will go through the transition of suddenly becoming flooded.
Since the contents (density) does not change at the transition, this downflooding will be more realistic if the content is seawater.

Hopper Spilling and Flooding

Spilling from a hopper which contains a combination of seawater and a denser liquid can be simulated by superimposing two identical tanks

where one contains sea water and is of the DAMAGED Type while the other contains the residual density and is of the SPILLING Type. The residual density would be the difference between sea water and the denser liquid.

----------o----------

Evaluating Vessels for Weather Criterion (46 CFR 170.170)

11/95

GHS is capable of evaluating the stability of a vessel based on the Weather Criterion (46 CFR 170.170). This criterion assumes that the righting arm curve has the form of a sine curve and the heeling arm curve has the form of the cosine as shown in (1) and (2).

Righting arm = GM sin í (1)

$$\text{Heeling arm} = \frac{P\,A\,H}{W}\cos í \quad (2)$$

where P = wind pressure A = projected lateral area H = the vertical distance from the center of the projected lateral area to the center of the underwater lateral area
W = displacement
í = 14 degrees or the angle at which one-half the freeboard to deck edge is immersed, whichever is less

The angle at which the heeling arm curve and righting arm curve intersect is the angle of equilibrium. Therefore, at equilibrium

$$GM \sin í = \frac{P\,A\,H}{W}\cos í \quad (3)$$

$$GM = \frac{P\,A\,H}{W \tan í} \quad (4)$$

The Weather Criterion requires that (4) must be satisfied for each condition of loading and operation. Three LIMIT commands are required by GHS in order to apply this criterion.

The first LIMIT command assures that the angle of equilibrium occurs before 14 degrees or the angle at which one-half the freeboard to deck edge is immersed, whichever is less. It is defined as

```
LIMIT(1) ANGLE from EQU to ABS 14 or HF > 0
```

The HF keyword (short for Half Freeboard) refers to the angle at which one-half the freeboard to deck edge is immersed. In this case, the angle from equilibrium to the lesser of 14 or HF must be greater than zero.

Before you can use the HF keyword, you must first mark the deck edge of the vessel. The deck edge is marked in Part Maker using the MARGIN command. For this criterion, the amount of the margin does not matter. You could use zero or any other value. For example,

```
modify hull\hull.c
margin 0
/
```

When you view the vessel using the DISPLAY command, you should see a line marking the deck edge.

GHS does not make the assumption that the righting arm curve is a sine curve -- actual righting arms are calculated for each angle of heel. If only the angle of equilibrium is considered, it is

possible to have a righting arm curve which satisfies LIMIT(1) above but has very little righting energy up to the angle í or, in extreme cases, a negative GM at zero heel. In order to insure that the true righting arm curve provides as much energy as would a sine curve, a second LIMIT command is required. It is derived from (1) and (2) as follows:

$$\text{Area RA} = \int_0^{\phi 2} \text{RA}\, d\phi$$

$$= \int_0^{\phi 2} GM \sin\phi\, d\phi$$

$$= -GM \cos\phi \Big|_0^{\phi 2}$$

$$= GM(1-\cos\phi 2)$$

$$\text{Heeling arm} = (GM \tan\phi 2)\cos\phi$$

$$\text{Area HA} = \int_0^{\phi 2} \text{HA}\, d\phi$$

$$= \int_0^{\phi 2} (GM \tan\phi 2)\cos\phi$$

$$= GM \tan\phi 2 \sin\phi \Big|_0^{\phi 2}$$

$$= GM \tan\phi 2 \sin\phi 2$$

$$= GM \frac{\sin^2\phi 2}{\cos\phi 2}$$

$$\frac{\text{Area RA}}{\text{Area HA}} = \frac{GM(1-\cos\phi 2)}{GM \frac{\sin^2\phi 2}{\cos\phi 2}}$$

$$= \frac{\cos\phi 2\,(1-\cos\phi 2)}{\sin^2\phi 2}$$

$$= 0.492 \text{ @ } \phi 2 = 14 \text{ degrees}$$

The following LIMIT command can therefore be used to force the righting arm curve to be equal or better than the sine curve with regard to area (energy).

LIMIT(2) ABS RATIO from ABS 0 to ABS 14 > 0.492

An additional limit is required to guarantee that stability exists beyond the angle of equilibrium. This could be a measure of the range of stability or the residual area. For example, if the range of stability is
to be at least 15ø beyond equilibrium the limit command would be,

LIMIT(3) ANGLE from EQ to RA0 > 15

To evaluate the stability of a vessel based on the Weather Criterion, you must also set the heeling moment. You can use the WIND and HMMT commands as follows:

```
WIND(PRESSURE)  P
HMMT  WIND  /CS
```

where P = the wind pressure as calculated according to 46 CFR 170.170(a). The values of A and H will be determined by GHS from the model and current waterplane. All superstructure that is to be included in the lateral area calculations must be modeled. If superstructure is to be included in the
lateral area calculations but not in the buoyant volume of the vessel, it must be modeled as a SAIL part. These commands will then generate the heeling arm curve as defined in (2).

Following is a simple run of commands which can be used to perform a weather criterion analysis:

```
READ filename
REPORT    WEIGHT w, l, t, v
LIMIT(1) ANGLE from EQ to ABS 14 or HF > 0
LIMIT(2) ABS RATIO from ABS 0 to ABS 14 > 0.492
LIMIT(3) ANGLE from EQ to RA0 > 15
WIND(PRESSURE) P
HMMT WIND /CS
HEEL = 0
RA 0,2 ... 14 /LIM
```

----------o----------

Wind Heeling Moment Calculations

5/95

Applies to GHS, BHS and BHS/YACHT

GHS offers several methods of modeling the effects of wind pressure, ranging from a constant heeling moment directly supplied by the user to a variable heeling moment automatically computed from wind pressure on the lateral plane.

Regardless of the method chosen, the HMMT command is the channel through which heeling moments are specified (even when the heeling moments arise from sources other than wind pressure).
Independently-calculated heeling moments are specified directly through the HMMT command -- no other commands are required. Internally-computed wind heeling moments require two preliminary steps before the HMMT command is invoked:
1) A representation of the vessel's lateral plane must be present in the geometrical model. While all buoyant parts are automatically included in the lateral plane, there may be other elements of the vessel which do not have significant buoyancy but which do have significant areas subject to wind pressure or lateral water pressure. These may be included in the model as parts with Class = SAIL (even if they are under water, such as a plate keel). SAIL parts are ignored when computing buoyancy, but their lateral projections are included with the lateral projections of the other
parts of the model (tanks, of course, are ignored when computing the lateral plane).
2) The WIND command, which specifies the wind pressure, must be executed. This command takes either a nominal wind speed (referred to 10 meters above the water surface) or a pressure vs. height function given by means of sample pressures at given heights. In the case where the wind speed is given, a drag coefficient may also be given in order to match the resulting wind pressure profile to a desired standard.

After these preliminary operations, the HMMT command may be issued in the form

HMMT WIND [/C2 ³ /CONST]

(the parameters in brackets being optional and mutually exclusive). With neither optional parameter, the heeling moment calculation is
deferred until a time when a heeling moment is actually needed at which time it is calculated from the lateral projection at the then present depth, heel and trim.

The presence of either the /C2 or the /CONST parameter causes a heeling moment to be calculated at zero heel and trim, using the current weight to obtain the depth.

Once the HMMT command has been issued, establishing a heeling moment function, there are three things which may done:

1) The SOLVE command may be issued to find the heel angle where heeling and righting moments are equal -- ie. the equilibrium heel angle in the presence of the wind.

2) The RA command may be issued to compute a residual righting arm curve.

3) The MAXVCG command may be used to find maximum VCG values relative to a suitable stability criterion. (Not available in BHS or BHS/YACHT.)

----------o----------

USCG Severe Wind and Rolling Criterion for Fishing Vessels

4/95

The calculation of the Severe Wind and Rolling Criterion required by the new USCG Commercial Fishing Vessel Safety Regulations is different
from the IMO Severe Wind and Rolling criterion as given in NVIC 5-86 and therefore requires a slightly different approach in GHS.
The IMO Severe Wind and Rolling criterion subjects the vessel to a steady wind heeling arm. The first intercept of the steady wind
heeling arm and the righting arm curve is the angle of equilibrium. The IMO criterion requires that the steady wind angle of equilibrium must be less than 14 degrees. The vessel is rolled to windward from the angle of equilibrium due to wave action and then is subjected to a
gust wind heeling arm. The gust wind heeling arm is 1.5 times greater than the steady wind heeling arm. The residual Area B must be greater than Area A as shown in NVIC 5-86.

The USCG Severe Wind and Rolling criterion no longer makes reference to the steady wind heeling arm. The angle of equilibrium is now taken at the first intercept of the gust wind heeling arm and the righting arm curve. The USCG criterion requires that the gust wind angle of equilibrium must be less than 14 degrees. The roll to windward, while quantitatively the same as IMO, is taken from the gust wind intercept and not the steady wind intercept. The residual areas are then compared as in the IMO criterion.
Several commands are available in GHS to calculate Severe Wind and Rolling for either the IMO or USCG criteria. The WIND 53.4 /CD:1.2
command specifies a steady wind speed (Vn) of 53.4 knots at a height (hn) 10 meters above the water as required in the IMO criterion. The
nondimensional drag coefficient is specificied in both criteria at 1.2 and is set with the /CD:Cd parameter.

The HMMT WIND /CONSTANT command will apply a constant heeling moment on the vessel according to the wind speed specified by the WIND command. The /GUST:1.5 parameter is used with the HMMT command to specify a gust
wind heeling moment 1.5 times greater than the steady wind heeling moment.

The ROLL IMO /K:k command will calculate the roll of the vessel to windward as defined in both criteria. The /K:k parameter must be calculated by the user according to the geometry of the vessel. If the /K:k parameter is used, you must leave a space between IMO and /K:k or the /K:k parameter will be ignored.
The LIMITS command is used to set the appropriate stability criterion.

IMO Calculation

Two steps are required for evaluating the IMO criterion with GHS. The first step is to find the steady wind heeling arm and evaluate whether
or not the steady wind angle of equilibrium is less than 14 degrees. The second step is to roll the vessel to windward and apply the gust wind heeling arm to compare Area B to Area A. The following is an excerpt from a run file that may be used, after loading the vessel, to evaluate the IMO criterion correctly.

```
`STEP 1 for determining equilibrium angle
lim(1) abs angle at equilibrium < 14
wind 53.4 /cd:1.2       hmmt wind /const                    hmmt report
solve
ra 0 /lim
```

```
`STEP 2 for comparing residual areas
lim(1) off
lim(2) res ratio from roll to abs 50 or ra0 > 1
lim(3) res ratio from roll to fld or ra0 > 1
wind 53.4 /cd:1.2     roll IMO /K:0.7     `Input appropriate k hmmt wind /const /gust:1.5
solve
he = * - roll
hmmt report ra 0, 5, ... 60 /lim
```

USCG Calculation

The major difference between the two criteria is where the angle of equilibrium is taken (i.e. steady wind intercept vs. gust wind intercept). The /GUST:1.5 parameter can not be used with the HMMT WIND command to calculate the required gust wind angle of equilibrium when evaluating the USCG criterion. The /GUST:1.5 parameter will not calculate the gust wind heeling arm until after the HE = *-ROLL command is excecuted. Therefore, the angle of equilibrium will be taken at the steady wind
intercept and the roll will be taken from the wrong angle of equilibrium.
To evaluate the USCG criterion correctly, the user must input a wind
speed which produces the correct gust wind heeling arm. Specifying a wind speed of 65.4 knots produces the same heeling moment as does setting a steady wind speed equal to 53.4 knots and using the
/GUST:1.5 parameter.
A user defined gust wind speed allows for the correct angle of equilibrium (i.e. gust wind intercept) to be evaluated. The roll will then be taken from the gust wind angle of equilibrium to windward before the residual areas are compared. Both limits can be set and evaluated in one step. The following is an excerpt from a run file that may be used, after the vessel is loaded, to evaluate the USCG criterion correctly:

```
lim(1) abs angle at equilibrium < 14
lim(2) res ratio from roll to abs 50 or ra0 > 1
lim(3) res ratio from roll to fld or ra0 > 1
wind 65.4 /cd:1.2
roll IMO /k:0.7          `Input appropriate k hmmt wind /const
hmmt report
solve
he = * - roll
ra 0, 5, ... 60 /lim
```

Maxvcg curves can be run using the same run files. The SOLVE, HE = *-ROLL, and RA commands should be replaced by the MAXVCG command. The MAXVCG command will solve for equilibrium and apply the roll correctly in its
iterative search for the maximum VCG.

Users should review and understand the Severe Wind and Rolling criteria and the applicable GHS commands before using GHS to perform the calculations. The HMMT REPORT and ROLL commands can be used to see how GHS is calculating the heeling moment and the roll angle.

- -

New Stability Standards for Small Fishing Vessels

Effective September 15, 1991, final regulation by the U.S. Coast Guard governing fishing vessels substantially tighten stability requirements.

The regulation is to implement provisions of the Commercial Fishing Industry Vessel Safety Act of 1988 and applies to vessels built after the effective date. It also affects those vessels that undergo major conversion and operate with 16 or more persons. Thirteen public hearings were held in all coastal regions of the United States. Concerns of the fishing industry centered upon the proposed adoption of IMO's stability standards. A group of Seattle Naval Architects submitted calculations and examples at the public hearing in Seattle to demonstrate that the proposed rules were far too severe and failed to take into account the manner in which any stability criteria compares to proven seaworthy designs. The new regulations, while different from IMO's stability standards, adopts the principles of IMO's "severe wind and rolling criterion".

----------o----------

Wind and Rolling Calculations

6/95

In the presence of wind pressure, a vessel may need to have enough righting energy available to absorb the kinetic energy due to a roll from a point to the windward of its equilibrium heel. GHS provides a mechanism for setting such a windward heel angle so that these energies can be compared.
With a heeling moment in effect (see the HMMT command), the equilibrium heel angle can be found simply by issuing the SOLVE command (without parameters). If the roll angle to windward of equilibrium is known, the heel angle can then be decremented simply by giving the command

```
HEEL *-r
```

where r is the desired roll angle.

A more powerful way of handling the roll angle is provided by the ROLL command. For example,

```
ROLL r
HEEL *-ROLL
```

does about the same thing as the HEEL *-r command, except that it always moves the heel angle in the direction opposite to the initial heel angle. Further, if the actual value of r is to be calculated from the present condition according to the IMO rolling formula, then the ROLL command may be given once in the form

```
ROLL IMO
```

and the actual value of r will be calculated when it is needed from the then-present condition.
A typical sequence of commands to check the energy available to resist an IMO roll would be:

```
ROLL IMO
WIND 53.4
HMMT WIND /CONST
SOLVE
HEEL *-ROLL
RA /AREA
```

If an increase in the heeling moment (due to a gust of wind) occurs at the rolled angle, it can be modeled by using a /GUST parameter on the HMMT command. The issuance of the HEEL -ROLL command then automatically causes the heeling moments to be multiplied by the gust factor from then on -- until another HMMT command is issued. For example,

```
...
HMMT WIND /CONST /GUST: 1.5
SOLVE
HEEL *-ROLL  `<-- The gust factor does not take effect until after this.
RA /AREA
```

When using the MAXVCG process, the roll angle and gust factor are automatically applied in the proper sequence. Thus

```
ROLL IMO
WIND 53.4   HMMT WIND /CONST /GUST: 1.5
SOLVE MAXVCG
```

is all that is necessary.

Further, the MAXVCG command automatically recalculates the wind moments at each new draft when they are based on the lateral plane. Hence

```
ROLL IMO
HMMT WIND /CONST /GUST: 1.5
MAXVCG ...
```

produces maximum VCG curves for a stability criterion involving the ROLL angle.

The LIMIT command, used for establishing stability criteria, accepts the keyword ROLL as an angle, in which case it actually refers to the *-ROLL angle. For example,

```
LIMIT RESIDUAL RATIO FROM ROLL TO ABS 50 OR FLD > 1
```

expresses the IMO criterion for severe wind and rolling.

----------o----------

GHS/BHS Demonstration Run File for End Launching

```
project launch
read tanker.gf

`report

`Light ship
weight = 6.0 @-97.57, 19.6 @-85.05,
       14.0 @-85.05, 22.8 @-5.04,
       20.0 @ -5.04, 21.2 @ 2.90 vcg = 5.7

`Keep heel fixed -- assumed to be supported by side blocking
heel = 0
fix heel

`Angle of slipway inclination relative to ship's baseline
trim = 15a

`Initial depth of water at ship's origin depth = -0.2

variable LS   `Location of aft end of slipway in ship's coordinates
set LS = 15.0a `Initial location

variable L1   `Location of forwardmost block in ship's coordinates
set L1 = 92.0f

variable DL  `Distance between blocks in ship's coordinates
set DL = 6.8

variable NB  `Number of blocks set NB = 14
`=========================================
\\\\\\End Launching Calculation\
\\Stern First\
\\\\
\\ Slipway inclination:                {TRIM} degrees
\\ Initial depth of water at ship's origin:      {DEPTH}
\\ Aft end of slipway relative to ship's origin: {LS}
\\ Forwardmost block relative to ship's origin:  {L1}
\\ Distance between blocks:                {DL}
\\ Number of blocks:                      {NB}
\\\(Distances in {LUNIT})\
\\Ship's origin is at {ORIGIN}\

variable N,L,D,DI

`Generate ground points for all blocks
macro blocks
 ground "Block {N}" 0, {L}, 0, 0
 set N = {N} PLUS 1
 set L = {L} PLUS {DL}
/
set N = 1
set L = {L1} .blocks ({NB})

macro err
```

```
 \ Error: %1
 wait
/

`Find depth increment for each step
set DI = SIN {TRIM} set DI = {DI} TIMES {DL}
`Find location of aftmost block
set L = {NB} MINUS 1 TIMES {DL} PLUS {L1}
if {L} > {LS} then .err "Blocks go beyond end of slipway" | end
`Find number of steps to take
set N = {LS} MINUS {L} DIV {DL} PLUS {NB}
macro step
 solve  subtitle
 \
 \===== End of Slipway {LS} {LUNIT} from Ship's Origin =====\
 page
 status weight, displ, wpl:total
 ls /notab
 set LS = {LS} MINUS {DL}
 set D = {depth} PLUS {DI}
 depth = {D}
 if {LS} > {L} then exit
 if {NB} < 1 then exit
 delete "Block {NB}"
 set NB = {NB} MINUS 1
 set L = {L} MINUS {DL}
/
.step ({N})

end
```